

19 month-olds represent and incrementally parse filler-gap dependencies

Mina Hirzel (University of Maryland), Laurel Perkins (Ecole Normale Supérieure) & Jeffrey Lidz (University of Maryland)
mhirzel@umd.edu

Adults process *wh*- object questions incrementally and predictively: they integrate fronted *wh*-phrases immediately upon encountering their anticipated position, as evidenced by filled-gap effects [1,2]. [3] argues that 5 year-olds don't show filled-gap effects. By separating active-filling and incremental integration, the current study shows that 19 month-olds interpret the fronted *wh*-phrase as the direct object upon hearing the verb in (1). This demonstrates that, before age 2, infants rapidly deploy their knowledge of argument structure to interpret non-local arguments.

- (1) What is she washing _ with *the tig*?
- (2) She's washing with *the tig*.
- (3) She's washing that thing with *the tig*.

To probe filler-gap dependency processing, we compared (1) and (2). Previous work shows that 19 month-olds use their verb knowledge to predictively parse local arguments of the verb [4]. In [4], infants watch videos (e.g., a woman using a sponge to wash a toy car) accompanied by intransitive sentences (2), which introduce a novel noun (e.g., *tig*).

At test, both the sponge and the car appear on opposite sides of the screen, and infants are asked to find the *tig*. 16 month-olds infer from (2) that *tig* means sponge, demonstrating that they assigned the right thematic relation to *the tig* during familiarization. Surprisingly, 19 month-olds infer that *tig* means car. The authors argue that the 19 month-olds' behavior is driven by their knowledge of the verb's transitivity: their expectation that *wash* is transitive overrides the bottom-up information from the sentence that *the tig* is the object of *with* and hence bears the instrument relation. Indeed, 19 month-olds correctly infer that *tig* means sponge when familiarized with a transitive frame (3), where the direct object appears in its canonical position.

Here, we ask if the direct object offers the same benefit when it's displaced. In this study, infants watch 6 video trials with a similar structure to those in [4] (Figure 1). The syntax during familiarization – intransitive (2) or *wh*-question (1) – is a between-subjects factor. To succeed at learning from (1) that *tig* means sponge, infants must (a) recognize that the fronted *wh*-phrase is the object of the verb and (b) use that information upon parsing the verb. If they can't use this information quickly enough, then infants will parse *the tig* as the direct object of *wash*. As a result, they will behave the same regardless of whether they're familiarized with (1) or (2).

We tested 64 infants (mean=19;25, range=19;2-21;3). Infants look more toward the car in the intransitive condition (2), reproducing findings from [4]. Critically, infants in the *wh*-condition (1) look reliably more toward the sponge than infants familiarized with (2) (Figure 2). We fit a linear mixed-effects regression model of proportion looks to instrument in R using the lme4 package [5], including as predictor variables test window, condition, and their interactions. Random intercepts were included for participants and items. Model comparison revealed a significant interaction between test window (baseline vs. test) and condition (intransitive vs. *wh*-question) ($\chi^2 = 3.97$, $p < 0.046$). Therefore, 19 month-olds must (a) know the syntax of *wh*-questions and (b) rapidly deploy that knowledge.

This study shows that 19 month-olds incrementally integrate non-local arguments in *wh*-object questions – a pre-requisite step to active-filling strategies. Further research is required to identify when children deploy active-filling strategies. More broadly, by 19 months-old, infants can (a) represent non-local dependencies (b) parse them incrementally and (c) use those representations to drive interpretation.

	Intransitive condition	Wh- question condition
Familiarization video:	Look at that! She's washing with the tig. Wow, do you see her washing with the tig? Hey, she's washing with the tig! Ooh, that's a nice tig.	Look at that! What is she washing with the tig? Wow, do you see what she's washing with the tig? Hey, what is she washing with the tig? Ooh, that's a nice tig.
Test screen:	Baseline: Where's the tig? Test: Which one's the tig?	Baseline: Where's the tig? Test: Which one's the tig?

Figure 1. Trial structure for *wash* (structure consistent for every verb). Other verbs included *hit*, *tickle*, *touch*, *pull*, and *wipe*.

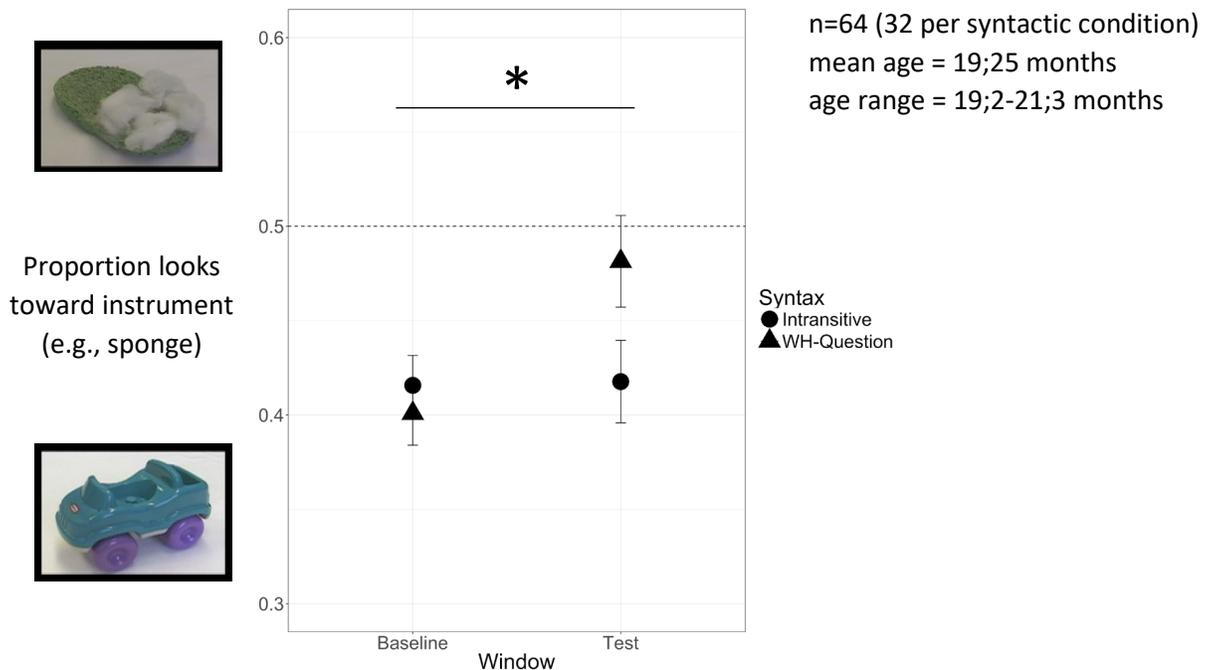


Figure 2. Proportion looks toward the instrument (e.g., sponge) in each syntactic condition (Intransitive vs. *Wh*-question) by Window (Baseline vs. Test). Baseline looks measured from the offset of the first test question: Where's the tig?. Test looks measured after the offset of the second test question: Which one's the tig?

Selected References. [1] Stowe, L. A. (1986). Parsing WH-constructions: Evidence for on-line gap location. *Language and cognitive processes*. [2] Pickering, M. J., Barton, S., & Shillcock, R. (1994). Unbounded dependencies, island constraints and processing complexity. *Perspectives on sentence processing*. [3] Atkinson, E., Wagers, M. W., Lidz, J., Phillips, C., & Omaki, A. (2018). Developing incrementality in filler-gap dependency processing. *Cognition*. [4] Lidz, J., White, A. S., & Baier, R. (2017). The role of incremental parsing in syntactically conditioned word learning. *Cognitive psychology*. [5] Bates, D., Maechler, M., & Bolker, B. (2013). *lme4: Linear mixed-effects models using Eigen and S4 classes*. R package version 0.999999-2.